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Measurement of Magnetic Quantities in Microelectromechanical Systems

SYSTEMS ENGINEERING FOR MEMS AND MOEMS

One of the directions of the essential improvement of the quality of microelectromechanical systems is the use of the limiting magnetic properties of the materials used in them. As a result it is necessary to develop the new methods and engineering facilities for measuring and monitoring of magnetic properties and performances of the parts of electromechanical systems, including the small-sized ones. The basic problems of such measuring lie in the nonlinear dependence of magnetic properties of the parts on the shape and geometrical dimensions of the systems, the essential action of magnetic-quantity sensor dimensions on the observed measuring results, the complexity, and frequent impossibility of the immediate measuring of the most informative magnetic performances and parameters. As a perspective method of magnetic measurement in microelectromechanical systems the method of full-scale-model trial is offered. It allows to merge both measuring, and modeling of the magnetic states of an object under trial into the integral measuring process. Thus the outcomes of the experiment are used as the initial data for modeling of magnetic fields in a microelectromechanical system as well as computation of the sensors' readings of magnetic quantities taking into account their geometrical dimensions and location. The model is adjusted as a result of an iteration process at each stage of which the adjustment of its parameters is carried out on the basis of comparison of the outcomes of a physical experiment and modeling.

One of the devices to perform a physical experiment while testing the articles from soft magnetic materials is ***Maghyst.*** Its measuring adapter is given in Fig. 1, where *1* – a part for testing; *2* – a magnetizing coil; *3*, *4* – sensors for measuring magnetic-field

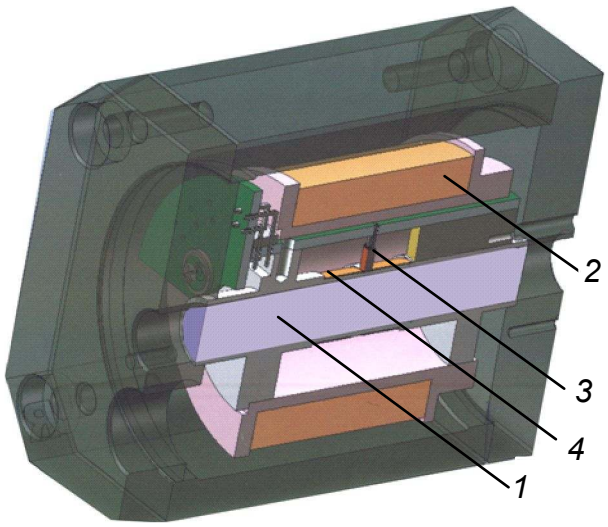

Fig. 1

intensity H and field density B accordingly. An observed measurement is magnetic performance $B(H)_e$. Magnetic field modeling in the device system is carried out by means of the applied program implementing computation of quantities H and B in the volumes occupied by sensors, resulting in estimated performance $B(H)_p$. Comparing performances $B(H)_э$ and $B(H)_p$ by means of a special procedure, the first approximation of required performance $B(H)_1$ is plotted. It is used for new calculation of the sensor readings. Process is iterated i times until the experimental and estimated performances coincide with the given accuracy. The corresponding approximation of required performance $B(H)_i$ is recognized as a final outcome of measuring.

Such an approach allows to essentially improve the accuracy of measurements. It is especially important while testing miniature parts with linear dimensions comparable with dimensions of sensors. The given method has wide applications due to the complex use of the achievements of magnet-measuring engineering and simulation of electromagnetic fields.

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